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COLOR TELEVISION POSSIBILITIES FOR THE POST WAR ERA

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Development of Color Pictures with Television Tubes

Regular transmissions in color were inaugurated in 1941 with daily programs over station WCBW of the Columbia Broadcasting System.

In order to understand the methods of color television transmission and reception now under consideration by the various research laboratories, one must first have a general idea of the principles employed in monochrome television. Since it is believed that the best practical system of producing television images will employ all-electronic methods, this is the type which will be discussed here.

Let us first consider a method of transmitting a "still" picture by radio. Since a single radio channel can convey only one electrical impulse at a time our entire picture cannot be sent in a single instant but must be divided into elements of infinitesimal size. Electrical impulses, the magnitude of which correspond to the amount of light reflected from each of these elements of area, are transmitted, one at a time, to the television receiver. At the receiver the impulses form a pattern for constructing the original image.

Television, the transmission of moving scenes, really requires transmission of many pictures each second, as in motion pictures, so that the eye will be deceived by the rapid succession of still pictures into believing it sees a continuous scene. It is necessary to send out information about each little element of each picture and to repeat the process so that thirty complete pictures are sent every second. Actually, present-day American standards of picture "definition", or clearness, require the transmission of the equivalent of 200,000 separate bits of information to make up the individual picture, or nearly 6,000,000 each second.

Those who are technically minded will be interested in the process of converting light into electricity and back again—a process known as "scanning". The picture is changed into an electrical form in the camera by the camera tube. At

the receiving end it is changed back into a picture in the picture tube.

Behind steadily increasing war activity, research engineers are now working on one of our great post-war sources of amusements—television. One of their more recent accomplishments has been the introduction of color, which adds life to the previous yellow-green replica.

Initial experiments with color television produced effects which were encouraging enough to warrant an extensive investigation of that field with the objective of producing a practical color television system. Here we shall note but a few of the great number of accomplishments which mark the progress of color television.

Color television, using mechanical scanning, was demonstrated for the first time by John L. Baird in England in 1926. In 1929 the Bell Telephone Laboratories developed a system of three-color television employing a separate radio channel for each color transmission. Although this method requires no mechanical devices for scanning its impracticability arises from the fact that the number of channels available for television transmissions is limited.

Dr. E. F. W. Alexanderson, famed radio and television engineer, developed another method in 1940, this time using a standard receiver with no additional equipment other than a two-color revolving disk.

THE TUBE ITSELF

Inside the camera tube is a plate which, because it is covered with myriads of tiny photoelectric cells, is sensitive to light. As each cell receives light from the viewed object focused upon the plate by a lens system, it sets up an electric charge in proportion to the amount of light falling upon it.

The scanning process removes the charges from the tiny cells on the surface of the plate or "mosaic" by means of a very thin beam of electrons shot out from an "electron gun" in the neck of the camera tube. The electron beam is caused to scan the mosaic by means of apparatus external

to the camera tube. Ordinarily, the scanning would be in successive horizontal lines beginning at the upper left edge of the mosaic and continuing downward ending at the lower right edge of the mosaic. However, since the lens system of the camera reverses the image on the mosaic, the actual scanning is from the lower right edge to the upper left edge. This scanning process is repeated 30 times per second; that is, each element of the picture is scanned by the electron beam 30 times per second.

COMPOSITION OF THE PICTURE

The picture comprises 525 horizontal scanning lines and, since each whole picture is scanned 30 times in one second, it can be computed that the scanning spot moves approximately 3 miles per second. As each tiny element of the mosaic is struck by the electron scanning beam, it gives up its charge, which is proportional to the intensity of the light at that particular spot on the mosaic. The charge is then transmitted over a cable to the amplifiers and the radio transmitter.

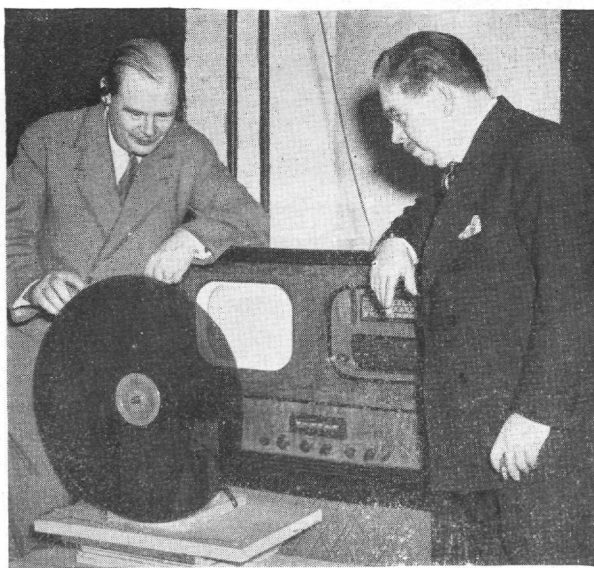
Upon reaching the television receiver, these electrical impulses are amplified and fed into the picture tube, where a beam of electrons scans the viewing end of the tube in exact synchronism with the electron beam in the camera. The viewing end of the picture tube is coated with fluorescent material, which glows when struck with the beam of electrons. The glow varies in proportion to the strength of the electron beam, which is constantly varying as the incoming signal varies. Thus, each individual point on the end of the picture tube glows with a different intensity, depending on the strength of the electron beam at the instant that particular point was struck. Because of this, the picture is made up of points of light and shadow—like the original scene. Synchronization of the electron beams in the camera and picture tubes is achieved by a separate electric impulse, which periodically co-ordinates the electron beam in the camera tube and the electron beam in the picture tube, bringing them back to the starting point together at the end of each line and at the end of each picture.

THE ADDITION OF COLOR

Color is added to the televised image by breaking down the original image into three basic colors; viz., magenta red, a certain shade of green, and one of blue—the same component colors used in motion pictures. A red image, a green image, and a blue image are placed before the spectator in very rapid succession. They blend together on the retina of the eye and produce the effect of real color blending in the picture. A red filter is placed before the lens of the camera tube for

1/120th second while the electron beam scans the image once. At the same time a red filter is placed between the observer and the fluorescent screen on the end of the picture tube in the receiver. During the next 1/120th second green filters replace the red ones; and these are, in turn, followed by blue. The flashes of color are introduced over and over again so rapidly that the eye is unable to distinguish the different flashes. It is seen, however, that, to prevent "color breakup", the electron beam is required to scan the image 120 times a second which is four times as fast as the "30 per" required to prevent flicker in monochrome television. In order to do this and still keep the number of electrical impulses transmitted each second within reasonable limits, the electron beam scans every other line during one trace and covers the intermediate lines during the next trace. To accomplish the rapid change of filters a motor-driven disk is spun in front of the camera tube at a rate of 1200 revolutions per minute. The disk is divided into six segments containing filters of the three different colors. Each segment consists of a single color, and segments of the same color are placed diametrically opposite each other on the disk. A similar disk is spun in front of the picture tube in synchronism with the disk at the transmitter.

As has been experienced with other media, color in television seems to introduce a certain perception of depth. This is partly due to the increased ability of color to reproduce the contrasts and shadows as well as highlights and reflections in different hues, while the degree of color saturation, which is a function of distance, especially outdoors, strongly enhances the three-dimensional quality.



—Courtesy of General Electric

Dr. Anderson demonstrates television receiver with two-color revolving disc.